



Faculty of Electronic and Computer Engineering

DESIGN OF WIDEBAND MICROWAVE BANDPASS FILTER WITH NOTCH CHARACTERISTIC USING DEFECTED STRUCTURE

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**DESIGN OF WIDEBAND MICROWAVE BANDPASS FILTER WITH NOTCH
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**A thesis submitted
in fulfillment of requirements for the degree of Master of Science
in Electronic Engineering**

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DECLARATION

I declare that this thesis entitled “Design of Wideband Microwave Bandpass Filter With Notch Characteristic Using Defected Structure” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name :

Date :

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electronic Engineering.

Signature :

Supervisor Name :

Date :

ABSTRACT

Bandpass filter is an essential component, in microwave wireless communication systems, which is typically used in both receivers and transmitters. Bandpass filter with wideband passband has been attracting a lot of interests of researcher to employing different methods and techniques. However, some existing radio systems that use narrow band signals, such as IEEE 802.11a WLAN in the band 5.2 GHz, can cause an interference with the wideband systems (3-6 GHz). Therefore, this thesis presents new techniques for the design of microwave bandpass filter at 3-6 GHz which cover wideband with fractional bandwidth of about 66.67%. The return loss is better than 16 dB and insertion loss is less than 0.9 dB. This filter was constructed by using short circuit stubs bandpass filter for microstrip structure and generalized Chebyshev bandpass filter for suspended stripline structure. The suspended stripline structure bandpass filter used the method of cascading generalized Chebyshev low-pass and high-pass filters. This technique provides various advantages such as reducing the number of elements and transmission zeros can be placed in arbitrary frequency response. In order to avoid the interference from existing system that operates in the frequency band, a defected structure was introduced to generate a narrow notch band. Then the defected structure with inverse T-shape will be integrated with the band-pass filter in order to provide high attenuation is 21 dB with narrow bandwidth of 5.83% and Q -factor of about 34.33. The second design is defected stripline structure with J-shape that integrated with a generalized Chebyshev bandpass filter. The notch response of measured value is 5.2 GHz at 25 dB resonant frequencies with fractional bandwidth of 6.79% and Q -factor is about 34.78. By integrating this defected structure, the overall size can be reduced about 15% and it provides easy technique to produce band reject response. This structure is very useful for wireless systems as it can be easily integrated with other planar devices. Advanced Design System (ADS) software was used to simulate the design from circuit element to physical momentum realization. The experimental results showed good agreement with the simulated results. The benefits of the integrated band-pass filter and defected structure are the reduction of the overall size, easier to fabricate and high Q -factor. This new design of microwave filter is considered suitable and an alternative solution for wireless and radar application without any addition of external components in the cascaded structure.

ABSTRAK

Penapis laluan lurus merupakan komponen penting di dalam sistem komunikasi tanpa wayar gelombang mikro yang biasanya digunakan pada kedua-dua penerima dan pemancar. Penapis laluan lurus dengan jalur lebar telah menarik minat ramai penyelidik untuk mengkaji dengan menggunakan kaedah dan teknik yang berbeza. Walaubagaimanapun, terdapat beberapa sistem radio yang menggunakan jalur isyarat yang kecil, seperti IEEE 802.11a WLAN iaitu di dalam jalur 5.2 GHz dan boleh menyebabkan gangguan terhadap jalur lebar (3-6 GHz). Oleh itu, tesis ini membentangkan teknik-teknik baru dalam mereka bentuk gelombang mikro penapis laluan lurus pada frekuensi 3-6 GHz yang mana meliputi jalur lebar dengan pecahan jalur lebar kira-kira 66.67%. Pekali pantulan adalah lebih baik daripada 16 dB dan pekali penghantaran adalah kurang daripada 0.9 dB. Penapis ini telah dibina dengan menggunakan short circuit stubs laluan lurus untuk struktur mikrojalur dan Chebyshev umum penapis laluan lurus untuk struktur stripline tergantung. Bagi struktur stripline tergantung, penapis laluan lurus dihasilkan dengan menggunakan kaedah gabungan Chebyshev umum laluan rendah dan laluan tinggi. Dengan menggunakan teknik ini, pelbagai kelebihan yang diperolehi antaranya dapat mengurangkan bilangan komponen dan transmission zeros boleh dibawa ke mana-mana frekuensi yang dikehendaki. Untuk mengelakkan gangguan dari sistem yang beroperasi dalam jalur frekuensi yang sedia ada, struktur hakisan telah diperkenalkan untuk menghasilkan tindak-balas notch. Kemudian, struktur hakisan berbentuk songsangan T akan disepadukan dengan penapis laluan lurus supaya dapat menyediakan kelemahan yang tinggi sebanyak 21 dB yang mempunyai tindakbalas notch sebanyak 5.83% dan faktor Q kira-kira 34.33. Reka bentuk kedua ialah struktur hakisan stripline dengan berbentuk J yang disepadukan dengan Chebyshev umum penapis laluan lurus. Tindak-balas notch yang diukur ialah 5.2 GHz pada 25 dB resonant frekuensi dengan pecahan lebar jalur adalah 6.79% dan faktor Q adalah kira-kira 34.78. Dengan menyepadukan struktur hakisan ini, keseluruhan saiz dapat dikurangkan kira-kira 15% dan menghasilkan teknik yang mudah untuk mengasingkan frekuensi yang tidak diingini. Struktur ini sangat berguna untuk sistem tanpa wayar kerana ia mudah untuk digabungkan dengan peranti satah yang lain. Perisian yang digunakan untuk simulasi ialah Advanced Design System (ADS) yang dimulakan dengan mereka bentuk elemen litar dan direalisasikan kepada bentuk momentum fizikal. Keputusan eksperimen yang ditunjukkan adalah sama dengan hasil simulasi. Kelebihan penapis laluan lurus bersepadu dan struktur hakisan adalah; pengurangan saiz keseluruhan, lebih mudah untuk direka bentuk dan faktor Q yang tinggi. Struktur baru penapis gelombang mikro dianggap sesuai dan penyelesaian alternatif kepada sambungan tanpa wayar dan aplikasi radar tanpa menggunakan penambahan komponen luaran untuk struktur tersebut.

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TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGMENT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES	ix
LIST OF APPENDICES	xix
LIST OF ABBREVIATION	xx
LIST OF SYMBOLS	xxi
LIST OF PUBLICATIONS	xxiii
AWARDS	xxv
 CHAPTER	
1. INTRODUCTION	1
1.0 Background	1
1.1 Problem Statement	3
1.2 Objectives	5
1.3 Scope of Work Problem Statement	5
1.4 Contribution of the Thesis	6
1.5 Thesis Organization	8
 2. LITERATURE REVIEW	10
2.0 Introduction	10
2.1 Basic Concept of Filter	11
2.1.1 Types of Filters	11
2.1.2 Degree of the Network, N	15
2.2 Important Definitions	16
2.2.1 Insertion Loss	16
2.2.2 Return Loss	17
2.2.3 Group Delay	17
2.3 Lumped Prototype Network and Circuit Transformation	18
2.3.1 Impedance Transformation	18
2.3.2 Lowpass to Arbitrary Cut-off Frequency Lowpass Filter	19
2.3.3 Lowpass to Highpass Transformation	20
2.3.4 Richard Transformation	21
2.3.5 Effects of Losses on Bandpass Filter	23
2.4 Realization of Microwave Filter	26
2.5 Microstrip Structure	28
2.5.1 Waves in Microstrip Line	29
2.5.2 Effective Dielectric Constant	29
2.5.3 Characteristic Impedance	30
2.6 Suspended Stripline Structure (SSS)	32
2.7 Wideband Filters	37

2.7.1	Comparison of Wideband, Moderate Band and Narrowband	37
2.7.2	Review of Wideband Microwave Bandpass Filter	38
2.8	Defected Structure	61
2.8.1	Defected Ground Structure (DGS)	61
2.8.2	Defected Microstrip Structure (DMS)	64
2.8.3	Defected Stripline Structure (DSS)	71
2.9	Summary	73
3.	RESEARCH METHODOLOGY	74
3.0	Introduction	74
3.1	Flow Chart of the Project	75
3.2	Design of Microwave Microstrip Bandpass Filter	78
3.2.1	Short Circuited Design	81
3.2.2	Physical Layout / Simulation	84
3.3	Generalized Chebyshev Lowpass Filter Design	85
3.3.1	Design of Generalized Chebyshev Lowpass Prototype	87
3.3.2	Generalized Chebyshev Lowpass Filter Utilizing Suspended Stripline Structure	89
3.4	Generalized Chebyshev Highpass Filter Design	93
3.4.1	Design of Generalized Chebyshev Highpass Prototype	94
3.4.2	Generalized Chebyshev Highpass Filter Utilizing Suspended Stripline Structure	97
3.5	Generalized Chebyshev Bandpass Filter Design	100
3.5.1	Design of Generalized Chebyshev Bandpass Prototype	100
3.5.2	Generalized Chebyshev Bandpass Filter Utilizing Suspended Stripline Structure	101
3.6	Defected Structure	104
3.6.1	Modeling Structure of Defected Microstrip Structure (DMS)	104
3.7	Fabrication and Measurement Process	106
3.8	Summary	107
4.	RESULTS AND DISCUSSION: WIDEBAND MICROWAVE BANDPASS FILTER	108
4.0	Introduction	108
4.1	Results of Bandpass Filter Based on Microstrip Structure	108
4.1.1	Stubs Element	108
4.1.2	Physical Layout	110
4.1.3	Fabrication and Measurement Results	115
4.2	Results of S-Shape Bandpass Filter Based on Microstrip Structure	118
4.2.1	Stubs Element	118
4.2.2	Fabrication and Measurement Results	121
4.3	Results of Lowpass Filter Based on Suspended Stripline Structure	124
4.3.1	Lowpass Filter Prototype and Distributed Element	124
4.3.2	Physical Layout of Lowpass Filter	126
4.3.3	Fabrication and Measurement Results	128
4.4	Results of Highpass Filter Based on Suspended Stripline Structure	130
4.4.1	Highpass Filter Prototype and Distributed element	130
4.4.2	Physical Layout of Highpass Filter	133

4.4.3	Fabrication and Measurement Results	135
4.5	Results of Bandpass Filter Based on Suspended Stripline Structure	137
4.5.1	Bandpass Filter Prototype and Distributed Element	137
4.5.2	Physical Layout of Bandpass Filter	138
4.5.3	Fabrication and Measurement Results	143
4.6	Comparison of Bandpass Filter with Other Researchers	146
4.7	Summary	148
5.	RESULTS AND DISCUSSION: INTEGRATED OF BANDPASS FILTER AND DEFECTED STRUCTURE	149
5.0	Introduction	149
5.1	Results of Defected Microstrip Structure (DMS)	149
5.1.1	Defected Microstrip Structure (DMS) with Conventional T-shape	150
5.1.2	Defected Microstrip Structure (DMS) with Inverse T-shape	152
5.2	Results of Defected Stripline Structure (DSS)	156
5.2.1	Defected Stripline Structure (DSS) with J-shape	156
5.3	Results of Integrated DMS with Bandpass Filter Microstrip Structure	160
5.4	Results of Integrated DSS with Bandpass Filter Suspended Stripline Structure	164
5.5	Comparison of Integrated Bandpass Filter and Notch Response with Other Researchers	170
5.6	Summary	172
6.	CONCLUSION AND FUTURE WORK	173
6.0	Conclusion	173
6.1	Future Work	175
	REFERENCES	176
	APPENDICES	187

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Comparison of selected literature reviews	59
2.2	Comparison of the structure of Defected Microstrip Structure (DMS)	70
3.1	Quarter-wavelength short circuited stub bandpass filter specification	78
3.2	Element values for Chebyshev lowpass prototype filters ($g_0 = 1.0$, $\Omega_c = 1$)	81
3.3	Design parameter of a 7 th order stub bandpass filter with quarter-wavelength short-circuited stubs	82
3.4	Microstrip design parameters of a 7 th order stub bandpass filter with quarter-wavelength short-circuited stubs	84
3.5	Lowpass filter design specification	87
3.6	Prototype element of lowpass filter	87
3.7	Summary of prototype and lumped element lowpass filter	89
3.8	Element value of distributed lowpass filter	93
3.9	Highpass filter design specification	94
3.10	Summary of prototype and lumped element highpass filter	96
3.11	Element value of distributed highpass filter	98
3.12	Summary of prototype and lumped element bandpass filter	101

3.13	Element value of distributed bandpass filter	103
4.1	Comparison of the previous researchers and this work based on wideband bandpass filter	147
5.1	Comparison for different shape of DMS	153
5.2	Comparison of the previous researchers and this work based on notch response	159
5.3	Comparison of the previous researchers and this work based on integrated wideband bandpass filter with notch response	171

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	RF front end of a cellular base station	2
1.2	Radio communication systems	3
2.1	Frequency response of (a) lowpass filter, (b) highpass filter, (c) bandpass filter and (d) bandstop filter	12
2.2	Types of response (a) lowpass Butterworth response, (b) lowpass Chebyshev response and (c) lowpass generalized Chebyshev response	14
2.3	Illustration of bandpass response with specific bandwidth	16
2.4	Comparison of different type of response	18
2.5	Lowpass prototype to lowpass filter with arbitrary frequency	19
2.6	Lowpass to highpass transformation	21
2.7	Richard transformation of lumped element to stub element (a) inductor to short circuit, (b) capacitor to open-circuit and (c) series of inductor and capacitor to open circuit.	23
2.8	Inductor with finite resistance	24
2.9	Circuit representations of resonators with finite resistances	25
2.10	Insertion losses as a function of different Q_u values	26
2.11	Example of various technologies in microwave filters	27

2.12	A basic of microstrip structure	28
2.13	Perspective view of Suspended Stripline Structure	33
2.14	Single suspended transmission line	33
2.15	Modification of Suspended Stripline from Stripline structure	34
2.16	Characteristic impedance of a Suspended Substrate Stripline	35
2.17	Comparison of the narrow band, moderate band and wideband response	38
2.18	Side-coupled line bandpass filter (a) fabricated devices and (b) S-Parameter for simulation and measurement	39
2.19	Embedding highpass filter stubs into stepped impedance lowpass filter (a) prototype and (b) S-Parameter	40
2.20	Filter using Hybrid Microstrip DGS (a) Prototype and (b) S-Parameter	41
2.21	Filter using short circuited stubs (a) Prototype and (b) S-Parameter	41
2.22	Filter using Parallel-Couple Microstrip Lines (a) Prototype and (b) S-Parameter	42
2.23	Filter short circuited stub method (a) fabricated and (b) S-Parameter	43
2.24	Bandpass filter with pair transmission zeros (a) physical layout, (b) insertion loss and (c) return loss	44
2.25	Coupled transmission lines (a) Structure of broadband bandpass filter (b) Simulated response of bandpass filter	45
2.26	Simulated and measured response of compact wideband banpass filter with fabricated structure	46
2.27	(a) A generalized Chebyshev lowpass prototype filter having 3	49

transmission zeros at infinity and (N-3) at a finite frequency and (b)

The Dual

2.28	Multiplexer covering the bands 500 MHz – 18 GHz	51
2.29	Printed circuit of highpass filter	52
2.30	(a) Layout of top and bottom the bandpass filter (b) Result of bandpass filter	53
2.31	Quarter-wave resonator and interdigital bandpass filter (a) physical layout and (b) response of bandpass filter	54
2.32	Suspended Stripline Structure resonator (a) Prototype filter and (b) S-Parameter	56
2.33	(a) Schematic view of the bandpass filter with two parasitic stubs (b) comparison between simulated (dashed line) and measured (continuous line)	56
2.34	Bandpass filter with notch using stub loader resonator (a) Layout of the structure and (b) Simulated and measured response	57
2.35	Bandpass filter with WLAN band rejection (a) The fabricated structure and (b) Comparison between the simulated and measured S_{21} parameter	58
2.36	Rectangular ring resonator (a) Layout of the wideband bandpass filter (b) Simulation response	59
2.37	The first DGS unit (a) Dumbbell DGS unit and (b) Simulated S-Parameter	62
2.38	Various types of DGS; (a) spiral head, (b) arrowhead-slot, (c) H-shape slots, (d) inverse T-shape, (e) open-loop dumbbell and (f)	63

	interdigital DGS.	
2.39	Unit cell (a) DMS and (b) DGS	65
2.40	Frequency response of two DMS (solid line) and DGS (dot line)	65
2.41	The bandstop filter with two T-shaped slots	66
2.42	(a) Proposed DMS and (b) Equivalent circuit	67
2.43	(a) Structure of DMS and DGS for dual band bandpass filter and (b) simulated and measured S-parameter	68
2.44	Band-notched ultrawideband bandpass filter (a) Fabricated structure (b) Simulated and measured response	69
2.45	(a) Structure of proposed defected microstrip structure and (b) structure of defected stripline structure	72
3.1	Flow chart of the project	76
3.2	Transmission line bandpass filter with quarter-wavelength short-circuited stubs	79
3.3	Modelling circuit of the proposed wideband bandpass filter	81
3.4	Simulation of short circuit stub bandpass filter	83
3.5	Layout of the designed microstrip bandpass filter with quarter wavelength short-circuited stubs	85
3.6	A generalized Chebyshev lowpass prototype filter	86
3.7	Equivalent circuit of the 7 th order generalised Chebyshev lowpass filter	88
3.8	Cross-section of suspended stripline structure	90
3.9	The 7 th order generalized Chebyshev lowpass distributed filter.	92
3.10	Physical layout of 7 th order generalized Chebyshev lowpass filter	93
3.11	The dual type generalized Chebyshev lowpass prototype filter	94

3.12	Seventh-degree generalized Chebyshev filter (a) lowpass prototype network (b) highpass prototype network.	95
3.13	The 7 th order generalized Chebyshev highpass distributed filter	97
3.14	Physical layout of 7 th order generalized Chebyshev highpass filter (a) top (b) bottom)	100
3.15	3-D view of suspended stripline structure highpass filter	100
3.16	Equivalent circuit of generalized Chebyshev bandpass filter	101
3.17	The 7 th order generalized Chebyshev bandpass distributed filter	102
3.18	Physical layout of the 7 th order generalized Chebyshev bandpass filter	103
3.19	(a) Conventional Defected Microstrip Structure (b) Inverse T-shape (c) Equivalent circuit model	105
3.20	Network analyzer and fabricated structure of bandpass filter	106
3.21	CNC and Milling machine for fabrication aluminum box	107
4.1	Simulation result of distributed element quarter-wavelength short circuited stubs bandpass filter	109
4.2	Simulation results of distributed element quarter-wavelength short circuited stubs bandpass filter with optimization response	110
4.3	Effect of the different diameter of via for shorting the stubs	111
4.4	3-D view of microstrip structure on EM simulation	112
4.5	Transmission line for optimization short circuited stub bandpass filter	113
4.6	Physical layout for optimization short circuited stub bandpass filter	113
4.7	Current flow visualization of short circuit stubs bandpass filter (a) at 3 GHz, (b) at 4.5 GHz and (c) at 6 GHz	114
4.8	3-D view of microstrip short circuited stubs	114

4.9	Simulated results of physical layout short circuited stubs bandpass filter	115
4.10	The fabricated of quarter-wavelength short circuited stubs bandpass filter	116
4.11	Comparison between simulated and measured response of quarter-wavelength short circuit stubs bandpass filter	117
4.12	Comparison group delay between simulated and measured response of quarter-wavelength short circuit stubs bandpass filter	117
4.13	Transmission line for optimization s-shape short circuited stub bandpass filter	119
4.14	3-D view of microstrip short circuit stubs with S-shape	120
4.15	Simulated results of physical layout compact structure S-shape short circuited stubs bandpass filter	120
4.16	Current flow visualization of short circuit stubs bandpass filter (a) at 3 GHz, (b) at 4.5 GHz and (c) at 6 GHz	122
4.17	The fabricated of S-Shape quarter-wavelength short circuited stubs bandpass filter	122
4.18	Comparison between simulated and measured response of compact S-shape quarter-wavelength short circuit stubs bandpass filter	123
4.19	Comparison group delay between simulated and measured response of compact S-shape quarter-wavelength short circuit stubs bandpass filter	124
4.20	Simulated response of generalized Chebyshev lowpass prototype	125
4.21	Simulated response of lumped element generalized Chebyshev	125

	lowpass filter	
4.22	Simulated response of distributed element generalized Chebyshev lowpass filter	126
	lowpass filter	
4.23	Physical layout of generalized Chebyshev lowpass filter	127
4.24	3-D view of generalized Chebyshev lowpass filter	127
4.25	Simulated response of physical layout generalized Chebyshev lowpass filter	128
	lowpass filter	
4.26	Current flow visualization of generalized Chebyshev lowpass filter at 6.0 GHz	128
4.27	The fabricated of generalized Chebyshev lowpass filter without lid	129
4.28	Comparison of simulated and measured generalized Chenyshev lowpass filter	130
	lowpass filter	
4.29	Simulated response of generalized Chebyshev highpass filter prototype	131
4.30	Simulation results of lumped element generalized Chebyshev highpass filter	132
4.31	Simulated response of distributed element generalized Chebyshev highpass filter	132
4.32	Physical layout of generalized Chebyshev highpass filter (a) top layer (b) bottom layer	133
4.33	3-D view of generalized Chebyshev highpass filter	134
4.34	Simulated response of physical layout generalized Chebyshev highpass filter	135
4.35	Current flow visualization of generalized Chebyshev highpass filter at	135

	3.1 GHz	
4.36	The fabricated of generalized Chebyshev highpass filter without lid	136
4.37	Comparison of simulated and measured generalized Chebyshev highpass filter	137
4.38	Simulation results of lumped element generalized Chebyshev bandpass filter	138
4.39	Proposed cascading of generalized Chebyshev bandpass filter	139
4.40	3-D view of generalized Chebyshev bandpass filter	139
4.41	Simulated response of physical layout generalized Chebyshev bandpass filter	140
4.42	Current flow visualization of generalized Chebyshev bandpass filter at 3.1 GHz	141
4.43	Right-angle strip conductor bends (a) mitered, (b) curve and (c) square	142
4.44	Equivalent circuit of bending strip conductor	142
4.45	Simulation response effect of the bending strip conductor on the bandpass filter	143
4.46	The fabricated of generalized Chebyshev bandpass filter without lid	144
4.47	Comparison of simulated and measured generalized Chebyshev bandpass filter	145
4.48	Comparison of simulated and measured group delay of generalized Chebyshev bandpass filter	145
5.1	Conventional T-shape Defected Microstrip Structure (DMS)	151
5.2	Parametric analysis on effect of different dimension l_2	151

5.3	Parametric analysis on effect of different dimension h_3	151
5.4	(a) Inverse T-shape of Defected Microstrip Structure (DMS) and (b) equivalent circuit of Inverse T-shape	153
5.5	Comparison of simulated conventional T-shape and proposed Inverse T-shape	153
5.6	The resonant frequency for different dimension of L_2	154
5.7	The resonant frequency for different dimension of h_2	155
5.8	The resonant frequency for different dimension of a	155
5.9	J-shape of defected stripline structure (DSS)	157
5.10	3-D view of Defected Stripline Structure (DSS)	157
5.11	The resonant frequency for different dimension of h_2	158
5.12	The resonant frequency for different dimension of h_3	158
5.13	The resonant frequency for different dimension of L_2	159
5.14	Proposed integrated of bandpass filter with inverse T-shape DMS	161
5.15	3-D view of microstrip short circuit stubs with DMS	161
5.16	Current flow visualization of integrated bandpass filter with DMS (a) at 3 GHz, (b) at 4.5 GHz and (c) at 6 GHz	161
5.17	Simulated results of integrated bandpass filter with DMS	162
5.18	The fabricated of integrated bandpass filter with DMS	162
5.19	Comparison between simulated and measured response of integrated bandpass filter with DMS	163
5.20	Comparison group delay between simulated and measured response of integrated bandpass filter with DMS	164
5.21	Proposed integrated of bandpass filter with J-shape DSS	165

5.22	3-D view of generalized Chebyshev bandpass filter with DSS	165
5.23	Current flow visualization of integrated bandpass filter with DSS (a) at 3.1 GHz, (b) at 6 GHz and (c) at 5.2 GHz	166
5.24	Simulated results of integrated bandpass filter with DSS	167
5.25	The fabricated of integrated bandpass filter with DSS	168
5.26	Comparison between simulated and measured response of integrated bandpass filter with DSS	169
5.27	Comparison group delay between simulated and measured response of integrated bandpass filter with DSS	169

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Roger Duroid RO4350B	187
B	Calculation for Impedance of Short Circuit Stubs	188
C	Calculation for length (l) and width (w) of the microstrip structure	192
D	Aluminium Box for Lowpass Filter	199
E	Aluminium Box for Highpass Filter	201
F	Aluminium Box for Bandpass Filter	203

LIST OF ABBREVIATION

<i>CNC</i>	-	Computer Numerical Control
<i>DGS</i>	-	Defected Ground Structure
<i>DMS</i>	-	Defected Microstrip Structure
<i>DSS</i>	-	Defected Stripline Structure
<i>EM</i>	-	Electromagnetic
<i>EBG</i>	-	Electromagnetic Band Gap
<i>PBG</i>	-	Photonic Band Gap
<i>RF</i>	-	Radio Frequency
<i>RX</i>	-	Recieve
<i>SAW</i>	-	Surface Acoustic Wave
<i>SIW</i>	-	Substrate Integrated Waveguide
<i>SSS</i>	-	Suspended Stripline Structure
<i>TEM</i>	-	Transverse Electromagnetic
<i>TX</i>	-	Transmit
<i>UWB</i>	-	Ultra-Wideband
<i>VNA</i>	-	Vector Network Analyzer
<i>WLAN</i>	-	Wireless Local Area Network